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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/418,818	10/15/1999	DAVID CHEUNG	AM1084D01/T9	9377

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APPLIED MATERIALS, INC.
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SANTA CLARA, CA 95050

EXAMINER	
ZERVIGON, RUDY	
ART UNIT	PAPER NUMBER
1763	21

DATE MAILED: 10/17/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

A-S-21

Office Action Summary	**Application No.**	**Applicant(s)**	
	09/418,818	CHEUNG ET AL.	
	Examin r	**Art Unit**	
	Rudy Zervigon	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the c rrespondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *22 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-6,9,10 and 44-62* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-6,9,10 and 44-62* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 1-6, 9, 10, 44-50, 53-57, and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 4,888,199) in view of J. Batey et al[1] and Fourmun Lee (U.S. Pat. 5,286,581). Felts et al (USPat. 4,888,199) teaches a PECVD process control and equipment (column 4, lines 8-31) where:

i. A substrate processing system, comprising:

ii. a process chamber (item 11, Figure 1;col.4,lines 8-31);

iii. a substrate support (item 53, Figure 2;col.4,lines 48-60), located within the vacuum chamber, for supporting a substrate (item 13, Figure 1,2)

iv. a power supply (item 17, Figure 1,2;col.3,line 61-65)

v. a gas delivery system (item 15, Figure 1,2;col.3,lines 59--61) for delivering process gases (col.5,lines 3-40) into the process chamber;

vi. a controller (item 27, Fig.1;col.5,line 27 through the end of the patent) configured to control the power supply (item 17, Figure 1,2;col.3,line 61-65,Both Felts et al) and the gas delivery system

vii. a memory (column 10, lines 56-64) coupled to the controller comprising a computer readable program (column 16 - column 46- Felts et al 4,888,199) having a computer readable program embodied therein for directing operation of the substrate processing system, the computer

readable program including a first (column 5, lines 16-40) set of computer instructions (column 16 -column 46 - Felts et al- 199) for controlling the gas delivery system to introduce selected deposition gases (column 5, lines 17-40) into the process chamber at deposited gas flow rates

viii. a second and fourth (column 10, lines 47-50; col.31) set of computer instructions for controlling the gas delivery system to add a flow of an inert gas (column 10, lines 47-50; column 6, lines 15-20; col.31) to the selected deposition gases at a flow rate previously determined

ix. a third set of computer instructions (column 11, lines 14-24, 47-49) for controlling the power supply to supply power to the process chamber

x. an oxygen gas source (column 6, lines 15-20)

Felts does not teach that the helium introduction is provided to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases, the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas to produce a plasma enhanced reaction of the deposition gases in the process chamber to deposit a film at the low deposition rate. Felts does not teach silane gas (SiH_4) or nitrous oxide (N_2O). Felts further does not teach:

i. a chamber pressure in the range of 1-6Torr

ii. silane (SiH_4) or nitrous oxide (N_2O) flowed into the chamber at a rate of 5-300 sccm

iii. a heater to heat the substrate to a temperature in the range of 200-400°C

iv. fifth set of computer instructions for controlling a heater

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[1] J. Bately and E. Tierney, "Low-temperature deposition of high-quality silicon dioxide by plasma-enhanced

v. helium (He) to combined silane (SiH_4) and nitrous oxide (N_2O) ratio of 6.25:1 or greater

vi. power applied to the process chamber in the range of 50-500Watts

vii. the volumetric flow rate of silane (SiH_4) is 0.5 to 3 times the volumetric flow rate of nitrous oxide (N_2O) – $0.5 < (SiH_4)/(N_2O) < 3.0$

viii. nitrous oxide (N_2O) flow rate between 15 to 160 sccm

Batey teaches a method of helium dilution to achieve low deposition rates and high quality films (Underlined Summary text). Specifically, Batey teaches that the helium introduction is provided to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases of silane and nitrous oxide (Section II), the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas (underlined text, Section III), to produce a plasma enhanced reaction of the deposition gases in the process chamber to deposit a film at the low deposition rate (section V, underlined text). Batey also teaches:

i. a process chamber ("Plasma Therm PK1250", Section II)

ii. a substrate support (not shown), located within the process chamber, for supporting a substrate (required)

iii. a gas delivery system (not shown) for delivering selected deposition gases into the process chamber at deposition gas flow rates (Table I, Page 3138)

iv. maintaining chamber pressure between 1 and 6 Torr (Section III, underlined text)

v. means for heating the substrate to a temperature between 200°C and 400°C (Section III, underlined text)

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chemical vapor deposition" *J.Appl.Phys.* **60**(9), 1 November 1986, pp.3136-3145

Batey also teaches a method of helium dilution to achieve low deposition rates and high quality films (Underlined Summary text). Specifically, Batey teaches that the helium introduction is provided to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases of silane and nitrous oxide (Section II), the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas (underlined text, Section III), to produce a plasma enhanced reaction of the deposition gases in the process chamber to deposit a film at the low deposition rate (section V, underlined text). Batey also teaches:

vi. a chamber pressure in the range of 1-6Torr (underlined text, Section III)

vii. silane (SiH_4) and nitrous oxide as nitrogen source (N_2O) flowed into the chamber at a rate of 5-300 sccm (Section II, Table I) where the helium (He) to combined silane (SiH_4) and nitrous oxide (N_2O) ratio of 6.25:1 or greater – (2000/140 = 14.28/1)

viii. a heater to heat the substrate to a temperature in the range of 200-400°C (underlined text, Section III)

ix. power applied to the process chamber at 25Watts (underlined text, Section III)

x. the volumetric flow rate of silane (SiH_4) is 0.5 to 3 times the volumetric flow rate of nitrous oxide (N_2O) – $0.5 < (SiH_4)/(N_2O) < 3.0$ because Batey teaches the claimed ratio at 0.4 – See Table I, page 3138

xi. the nitrous oxide (N_2O) flow rate between 15 to 160 sccm because Batey teaches nitrous oxide (N_2O) a flow rate of 100 sccm (Table I)

Felts and Batey do not teach CVD layer thickness control such that the CVD layer thickness is an odd multiple, greater than one, of a wavelength of light to be used in a subsequent process on the layer.

Fourmun Lee teaches:

i. means for forming a layer of photoresist (14, Fig.1;column 3, line 65- col.4, line 5) on the antireflective layer (13, Fig.1;column 3, lines 46-64), the antireflective layer (13, Fig.1;column 3, lines 46-64) having a thickness ("d", col.5, lines 10-15) and refractive index ("n", col.5, lines 10-15) such that a first reflection from an interface between the photoresist and the antireflective layer of an exposure light ("L", col.5, lines 10-15) will be a number/multiple (1/(2(n-1) – the inverse of all odd numbers, for n as integer; column 5, lines 10-15) multiplied by 180° (column 5, lines 15-25) out of phase with a second reflection from an interface between the antireflective layer and the substrate layer (12', 13'; column 5, lines 5-10) of the exposure light; and means for forming a photoresist pattern (column 5, lines 52-57) by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

ii. A silicon nitride and silicon oxynitride antireflective layer (12', 13'; column 5, lines 20-30; column 3, line 49) with refractive index in 1.7-2.9 (2.05, column 5, line 27) and a thickness of 200-3000 (1,738 ; column 5, line 27) and an light exposure wavelength of 365nm or less (column 5, line 24).

Although Fourmun Lee teaches only n radians, where n=1, out of phase between consecutive areas 12' and 13', it would have been obvious to one of ordinary skill in the art at the time the invention was made to realize that odd multiples of radians is the same phase angle.

Although Fourmun Lee does not mention the absorptive index of the antireflective layer for a silicon oxynitride material, it is the position of the examiner that the absorptive index of silicon oxynitride for the claimed wave length of 365nm and taught by Fourmun Lee (column 5, line 24) is a fixed intrinsic property of the silicon oxynitride material for the wavelength in question. As such Fourmun Lee teaches the absorptive index at the wavelength in question.

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Felts to use the Batey method of helium dilution of the process gasses and to introduce a heater controlled between 200-400°C and power applied between 50-500Watts, including for Felts and Batey to use the Lee method to form a layer of photoresist on the antireflective layer as taught by Fourmun Lee.

Motivation for Felts to use the Batey method of helium dilution of the process gasses and to introduce a heater controlled between 200-400°C including to optimize the power and gas flow rates, including for Felts and Batey to use the Lee method to form a layer of photoresist on the antireflective layer as taught by Fourmun Lee is to achieve larger density films with good electrical integrity and that are pinhole-free as taught by Batey (Section V. Conclusion) and to fabricate microelectronics by photolithographic technique (column 1, lines 9-30) including providing a phase-shift mask for reducing diffraction effects found in common photolithographic techniques as taught by Forum Lee (column 2, lines 32-48). Further, it would be obvious to those of ordinary skill in the art to optimize the operation of the claimed invention as taught by Batey (Section III, underlined text, In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980); In re Hoeschele , 406 F.2d 1403, 160 USPQ 809 (CCPA 1969); Merck & Co. Inc . v. Biocraft

Laboratories Inc. , 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied , 493 U.S. 975 (1989); In re Kulling , 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990), MPEP 2144.05).

3. Claim 51 is rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 4,888,199), J. Batey et al, Fourmun Lee (U.S. Pat. 5,286,581), in view of Felts et al (USPat. 5,364,665). Felts et al (USPat. 4,888,199), Batey, and Lee are discussed above.

Felts et al (USPat. 4,888,199), Batey, and Lee do not teach the substrate support is spaced from the gas distribution system at a distance in the range of 200-600 mils = 0.2-0.6 inches, where mils is interpreted as milli-inches

Felts et al (USPat.5,364,665) teaches:

xviii. a substrate support is spaced "Δ" (column 6,line 62-col.7,line 10) from the gas distribution system at a distance in the range of 200-600 mils = 0.2-0.6 inches, where mils is interpreted as milli-inches – "Distance should be no greater than about 12 inches... or - Δ < 12"

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Felts et al (USPat. 4,888,199) to space the substrate support from the gas distribution system at a distance in the range of 200-600 mils = 0.2-0.6 inches taught by Felts et al (USPat.5,364,665).

Motivation for Felts et al (USPat. 4,888,199) to space the substrate support from the gas distribution system at a distance in the range of 200-600 mils = 0.2-0.6 inches is to effect sufficient plasma confinement as taught by Felts et al (USPat.5,364,665; column 6, lines 65-68).

4. Claims 52, 58, and 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 4,888,199), J. Batey et al, and Fourmun Lee (U.S. Pat. 5,286,581), in view of Collins et al (USPat. 5,300,460). Felts, Batey, and Lee are discussed above. Felts, Batey, and Lee

do not teach deposition gases further comprising NH_3 flowed into the chamber at a rate of less than 300 sccm, and N_2 flowed into the chamber at a rate of less than 4000 sccm.

Collins teaches a method of producing semiconductor films (abstract). Specifically, Collins teaches deposition gases further comprising NH_3 flowed into the chamber at a rate of less than 300 sccm, and N_2 flowed into the chamber at a rate of less than 4000 sccm (column 12, lines 58-68).

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Felts et al (USPat. 4,888,199) to replace nitrous oxide with the deposition gases of NH_3 and N_2 at the flow rates taught by Collins.

Motivation for Felts et al (USPat. 4,888,199) to replace nitrous oxide with the deposition gases of NH_3 and N_2 at the flow rates taught by Collins is to produce silicon nitride films (column 12, lines 59-60).

5. Claims 60 and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over J. Batey et al in view of Fourmun Lee (U.S. Pat. 5,286,581). Batey teaches a substrate processing system as discussed above. However, Batey does not teach:

i. means for forming a layer of photoresist on the antireflective layer, the antireflective layer having a thickness and refractive index such that a first reflection from an interface between the photoresist and the antireflective layer of an exposure light will be an odd number which is at least 3 multiplied by 180° out of phase with a second reflection from an interface between the antireflective layer and the substrate layer of the exposure light; and means for forming a photoresist pattern by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

ii. A silicon oxynitride antireflective layer with refractive index in 1.7-2.9 and absorptive index in 0-1.3 and a thickness of 200-3000 and an light exposure wavelength of 365nm or less.

Fourmun Lee does teach:

iii. means for forming a layer of photoresist (14, Fig.1;column 3, line 65- col.4, line 5) on the antireflective layer (13, Fig.1;column 3, lines 46-64), the antireflective layer (13, Fig.1;column 3, lines 46-64) having a thickness ("d", col.5, lines 10-15) and refractive index ("n", col.5, lines 10-15) such that a first reflection from an interface between the photoresist and the antireflective layer of an exposure light ("L", col.5, lines 10-15) will be an odd number (1, in this case; column 5, line 6) which is not at least 3 multiplied by 180° (in radians) out of phase with a second reflection from an interface between the antireflective layer and the substrate layer (12', 13'; column 5, lines 5-10) of the exposure light; and means for forming a photoresist pattern (column 5, lines 52-57) by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

iv. A silicon nitride and silicon oxynitride antireflective layer (12', 13'; column 5, lines 20-30; column 3, line 49) with refractive index in 1.7-2.9 (2.05, column 5, line 27) and a thickness of 200-3000 (1,738 ; column 5, line 27) and an light exposure wavelength of 365nm or less (column 5, line 24).

Although Fourmun Lee teaches only n radians, where n=1, out of phase between consecutive areas 12' and 13', it would have been obvious to one of ordinary skill in the art at the time the invention was made to realize that odd multiples of radians is the same phase angle.

Although Fourmun Lee does not mention the absorptive index of the antireflective layer for a silicon oxynitride material, it is the position of the examiner that the absorptive index of silicon

oxynitride for the claimed wave length of 365nm and taught by Fourmun Lee (column 5, line 24) is a fixed intrinsic property of the silicon oxynitride material for the wavelength in question. As such Fourmun Lee teaches the absorptive index at the wavelength in question.

It would have been obvious to one of ordinary skill in the art at the time the invention was made for Batey to form a layer of photoresist on the antireflective layer as taught by Fourmun Lee. Motivation for Batey to form a layer of photoresist on the antireflective layer as taught by Fourmun Lee is to fabricate microelectronics by photolithographic technique (column 1, lines 9-30) including providing a phase-shift mask for reducing diffraction effects found in common photolithographic techniques, as taught by Forum Lee (column 2, lines 32-48).

Response to Arguments

6. Applicant's arguments filed April 22, 2003 have been fully considered but they are not persuasive.

7. Applicant states that Lee does not teach that a "first reflection" (assumed to be a thickness) between Lee's photoresist layer (14, Fig.1;column 3, line 65- col.4, line 5) and Lee's antireflective layer (13, Fig.1;column 3, lines 46-64) is an odd multiple, greater than one, of the wavelength of light. In response, Lee clearly teaches Applicant's claimed distance as being a multiple, less than one, of the wavelength of light – Applicant teaches on page 10 that said thickness is:

$$t = \frac{m\lambda}{2n}$$

while Lee teaches in column 5, lines 10-15:

$$t = \frac{m\lambda}{2n-2}, m = 1$$

as such, it is accepted that one of ordinary skill in the art at the time the invention was made would have found it obvious to optimize the operation of the claimed apparatus to achieve the claimed distance. It would be obvious to those of ordinary skill in the art to optimize the operation of the claimed invention as discussed by Lee (column 3, line 62 – column 4, line 27). - In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980); In re Hoeschele , 406 F.2d 1403, 160 USPQ 809 (CCPA 1969); Merck & Co. Inc . v. Biocraft Laboratories Inc. , 874 F.2d 804, 10 USPQ2d 1843 (Fed. Cir.), cert. denied , 493 U.S. 975 (1989); In re Kulling , 897 F.2d 1147, 14 USPQ2d 1056 (Fed. Cir. 1990), MPEP 2144.05).

8. Applicant states that the cited references do not teach light exposure at wavelengths of 365nm or less. However, it was established above that Lee teaches silicon nitride and silicon oxynitride antireflective layer (12', 13'; column 5, lines 20-30; column 3, line 49) with refractive index in 1.7-2.9 (2.05, column 5, line 27) and a thickness of 200-3000 (1,738 ; column 5, line 27) and an light exposure wavelength of 365nm or less (column 5, line 24).

9. In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., "the first reflection having almost the same intensity as the second reflection to thereby substantially cancel the first and second reflections") are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Conclusion

10. Applicant's amendment necessitated the new grounds of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Rudy Zervigon whose telephone number is (703) 305-1351. The examiner can normally be reached on a Monday through Thursday schedule from 8am through 7pm. The official after final fax phone number for the 1763 art unit is (703) 872-9311. The official before final fax phone number for the 1763 art unit is (703) 872-9310. Any Inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Chemical and Materials Engineering art unit receptionist at (703) 308-0661. If the examiner can not be reached please contact the examiner's supervisor, Gregory L. Mills, at (703) 308-1633.

GREGORY MILLS
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